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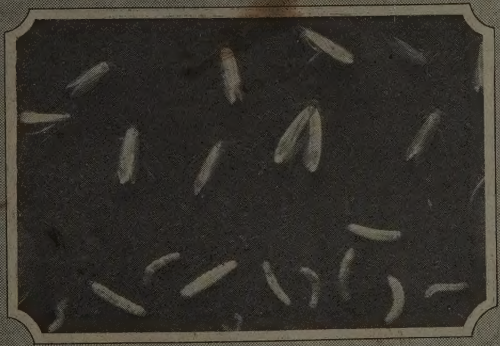
CLOTHES MOTHS AND THEIR CONTROL



COMPLETE elimination of clothes moths from the home is difficult. They breed not only in wearing apparel, but in carpets, rugs, and upholstered furniture, a single piece of which may often furnish a steady supply of moths to restock an entire house.

Clothes moths can be reduced, however, in any home or establishment by using the control measures described in this bulletin. Persons owning clothing subject to attack can afford to buy chests or cabinets that are very tight in which to store them. Trunks are usually not moth-proof. Red cedar chests when in good condition are among the tightest containers on the market. Such chests keep out the moths, and the characteristic odor of their wood kills any newly hatched or young clothes moth larvæ that may be confined in them with the clothing. Tight chests or cabinets whose walls can be made to absorb as much cedar oil as is found in the wood of containers of equal size are as valuable as cedar chests. Chests made of other well-seasoned wood or of metals with tightly fitting covers or doors, while they have no killing value in themselves, can be used safely as containers in which to treat clothing with naphthalene, paradichlorobenzene, carbon disulphid, or carbon tetrachlorid. Proper use of these four substances, which are simple and safe in application, will save thousands of dollars annually.

Cold storage for summer protection of furs and valuable fabrics has no equal, but may be beyond the means of some. Fumigation with hydrocyanic-acid gas is probably the best method of eradicating fabric pests from entire houses and storage rooms, but on account of its danger to human life should be used only by those who have had experience with it or are capable of following directions carefully. Sulphur fumes are not so valuable but are very serviceable at times. If dry heat, hot water, and soap solutions are used intelligently, in connection with tight wrapping in paper and thorough brushing, beating, and sunning, the thrifty housewife will be able to safeguard articles with the least expenditure of money.

Women's clubs and neighborhood organizations, by pooling their needs, as for instance in securing naphthalene or paradichlorobenzene, two chief and very safe controls, can greatly reduce expenses by buying in quantity from local dealers or from manufacturing chemists. Names and addresses of the latter will be furnished on application.

Washington, D. C. July, 1923

CLOTHES MOTHS AND THEIR CONTROL.

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CLOTHES MOTHS THE CHIEF PESTS OF FABRICS.

CLOTHES MOTHS are the prime offenders among fabric pests. The moths or "millers" most common about houses have a wing spread of about half an inch and are yellowish or buff-colored. They very seldom fly directly to a light in a room and remain flitting about it, as do so many small and large moths that enter houses from outside. Moths that fly in large numbers about the home light are generally feeders upon outdoor vegetation and will not eat household fabrics. Their presence in the house is accidental—they have merely been lured inside by the lighted lamp.

The common clothes moths are usually seen flying in darkened corners and just beyond range of the brightest rays of the lamp. They prefer darkness. They are frightened when clothing and other objects are suddenly moved, and are then seen running rapidly or flying to conceal themselves in the creases of clothing, cracks, or other dark places.

HARMLESS MOTH MILLER PARENT OF DESTRUCTIVE WORM.

The moths, or millers as they are often called, have imperfectly developed mouth parts and could not feed upon fabrics if they desired. Their purpose in life is merely to lay eggs that develop into the worms or larvæ, which alone can cause destruction. Nevertheless, every moth killed helps to reduce infestations by preventing

more eggs being laid. The moths lay their eggs in and about clothing and other objects subject to attack. From the eggs are hatched the larvæ, or worms. When these become fully grown, they are whitish and about half an inch long. The larvæ spin cocoons in which they transform to the pupa or chrysalis stage, and during this stage the insect changes to the adult, or moth. Thus each generation of clothes moths passes through four distinct stages, namely, the egg (Fig. 15), the larva or worm (Figs. 1, 2, 4, and 8), the pupa or chrysalis (Fig. 6), and the adult or moth (Figs. 1, 4, 7, and 8). Only the worm or larva of the clothes moth is capable of destroying fabrics.

COMMON SPECIES OF CLOTHES MOTHS.

There are two very common species of clothes moths. They are the case-making clothes moth[1] and the webbing clothes moth.[2] The tapestry moth[3] is less often found, though it may become destructive.

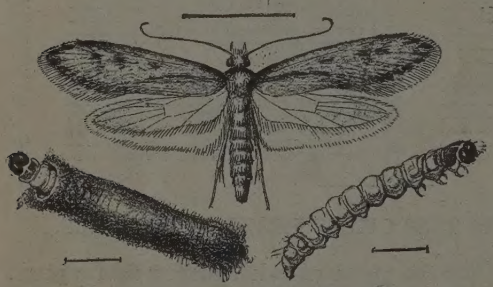

FIG. 1.—Case-making clothes moth: Above, adult; at right, larva; at left, larva in case. Enlarged. (Riley.)

THE CASE-MAKING CLOTHES MOTH.[4]

The adult of the case-making clothes moth has a wing expanse of about half an inch. Its head and forewings are grayish yellow or buff, with indistinct dark spots on the middle of the outer portions. The hind wings are white or grayish and silky.

The case-making clothes moth (Fig. 1) is so named because the larva, for its protection, makes a portable case out of spun silk and fragments of the fabric upon which it feeds. These cases attain a length of from four-sixteenths to six-sixteenths of an inch and are shaped as illustrated in Figures 1 at left and 2, *a*, *c*. The larva almost never leaves its case. It withdraws completely into it when resting, but when feeding or moving from place to place it merely protrudes its head and first body segments, as illustrated in Figure 1, at left. The larva spins almost no web on the fabric upon which it feeds, and is more likely to crawl about restlessly, eating small holes here and there (Fig. 2, *d*, and Fig. 3).

As the larva grows it enlarges its case from time to time, both in length and in circumference. This enlarging process has been interestingly described as follows:

> Without leaving its case the larva makes a slit halfway down one side and inserts a triangular gore of new material. A similar insertion is made on the opposite side, and the larva reverses itself without leaving the case and makes

[1] *Tinea pellionella* L.
[2] *Tineola biselliella* Hummel.
[3] *Trichophaga tapetzella* L.
[4] *Tinea pellionella* L.

corresponding slits and additions in the other half. The case is lengthened by successive additions to either end. Exteriorly the case appears to be a matted mass of small particles of wool; interiorly it is lined with soft whitish silk. By transferring the larva from time to time to fabrics of different colors the case may be made to assume as varied a pattern as the experimenter desires, and will illustrate, in its coloring, the peculiar method of making the enlargements and additions described.[5]

On reaching full growth the larva attaches its case by silken threads to the material upon which it has been feeding, or it may crawl, carrying its case, to another part of the room. In either instance, after attaching the case, it seals it with silk, thus making a pupal chamber wherein it transforms from the helpless pupa or chrysalis to the pretty and active moth.

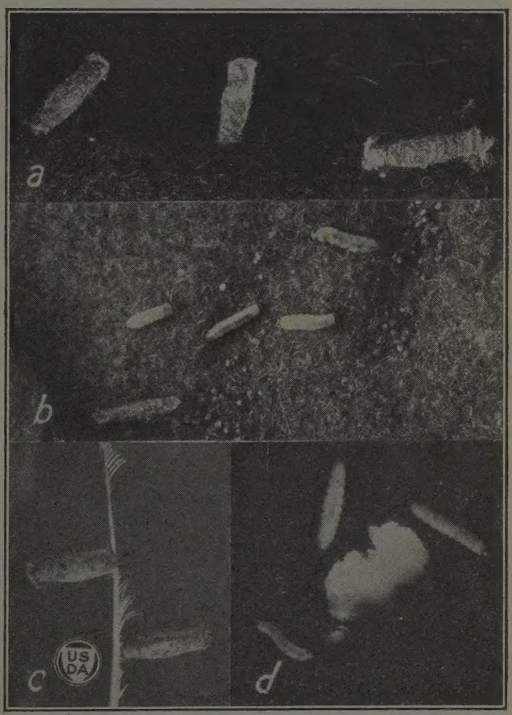

FIG. 2.—Case-making clothes moth: *a*, Three cases nearly twice natural size; *b*, larvæ removed from cases, and pellets of excrement; *c*, cases attached to damaged feather, about one and one-third times natural size; *d*, characteristic damage by larvæ to cloth.

THE WEBBING CLOTHES MOTH.[6]

The adult (Fig. 4, above) of the webbing clothes moth is of about the same size as that of the case-making species, but its color is uniformly pale buff without spots. The moths of both species vary considerably in size; they seldom have a wing expanse of over half an inch, and frequently are very much smaller.

The webbing clothes moth is the most abundant and injurious clothes moth. During the last few years, also, practically all instances of severe clothes-moth damage reported by manufacturing plants throughout the North, including Chicago, Boston, and New York, have been associated with this species. For years it has been the prevailing species in certain houses in western Massachusetts and southeastern Connecticut, hence it can not be said that this webbing clothes moth is typically southern in distribution, although it is often called the "southern" clothes moth.

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[5] C. L. Marlatt, in Bulletin 4, new series, Division of Entomology, U. S. Department of Agriculture, p. 65. 1896.

[6] *Tineola biselliella* Hummel.

The larva (Fig. 4) of the webbing clothes moth resembles that of the case-making moth. Unlike the latter, however, it makes no portable case, but spins silky transparent tubes or tunnels wherever

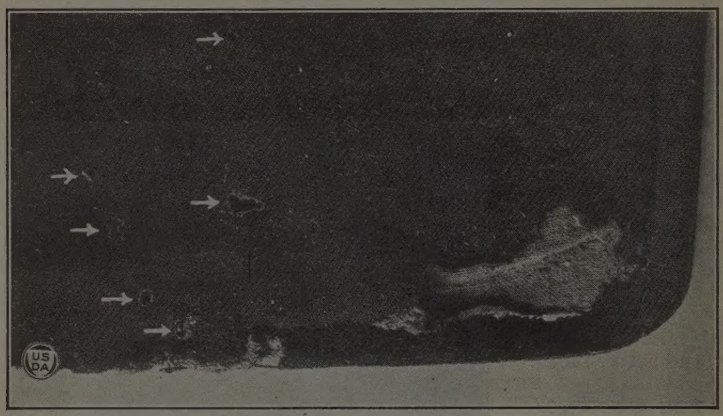

FIG. 3.—Section of man's coat damaged by case-making clothes moth. Note large eaten area at lower corner and along lower edge and small holes eaten at arrows.

it goes (Figs. 5, 14, and 16). Often it spins a cobwebby mass of silken threads, apparently at random, as it craws about fabrics, which gives to its food an unsightly appearance. The larvæ may

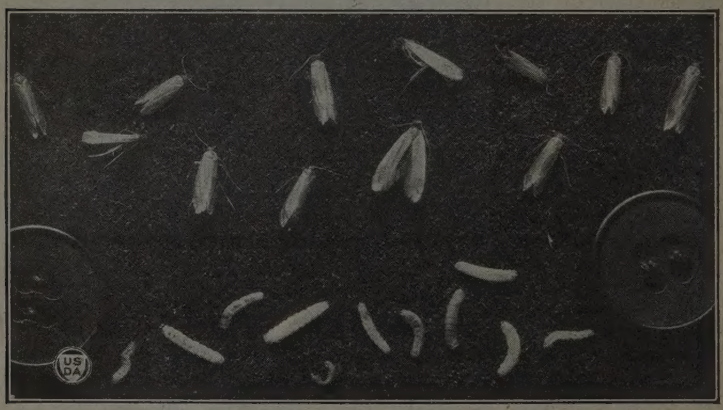

FIG. 4.—Webbing clothes moth: Adults or moths above and larvæ or worms below. Buttons are nine-sixteenths of an inch in diameter.

be quite restless, and often may be seen crawling over fabrics, or upon floors beneath upholstered furniture from which they have dropped. They attain a length of about half an inch and are white. The title-page illustration gives a good idea of the relative size of

the larvæ and moths; the buttons shown are nine-sixteenths of an inch in diameter. When the larva becomes full grown, it spins a cocoon of silk, intermixed with bits of fabric and excrement (Fig. 6), which is quite distinct from the case (Fig. 2, *a*, *c*) made by the case-making clothes moth. Within this cocoon the transfor-

FIG. 5.—Work of the webbing clothes moth in piece of cloth with heavy nap. Note long, narrow tube in which the larva secretes itself and from which it feeds upon the cloth. To the right of the tube is shown an area over which the larva has eaten off the nap, leaving the warp exposed.

mation from the larva to the adult takes place, and, as in the case of the other species, the chrysalis works its way partly out of the cocoon as the moth is about to emerge (Fig. 6).

THE TAPESTRY MOTH.[7]

The tapestry moth (Fig. 7) is not so common in the United States as the two foregoing clothes moths. It is larger than either the case-making or the webbing clothes moth, having a wing expanse of about three-fourths of an inch, and is more strikingly colored. Its head and the basal third of its forewings are black, while the outer two-thirds of the wings are creamy white, though more or less obscured on the middle with gray. The hind wings are uniformly pale gray.

[7] *Trichophaga tapetzella* L.

The tapestry moth is said to prefer coarser and heavier fabrics than the other two species of moths. It is more likely to occur in carpets, horse blankets, tapestries, felting, furs, and skins. The larvæ con-

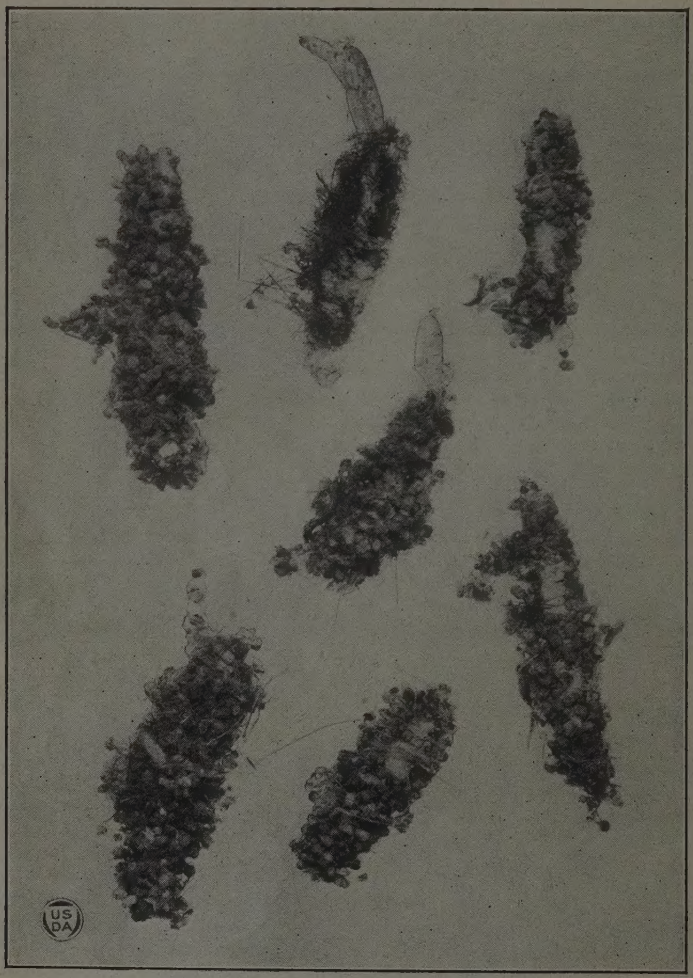

FIG. 6.—Pupal cases of the webbing clothes moth. Note that moths have emerged from two central cases, leaving behind the characteristic protruding pupal skins.

struct burrows or silk-lined galleries in all directions throughout the infested material, and often cause quite as much injury by these as by the amount of the fabric that is actually eaten. The tapestry moth has been reported as destructive to wall paper.

FOOD OF CLOTHES MOTHS.

Clothes moths feed upon wool, fur, hair, feathers, and all fabrics (Figs. 8, 9, and 10) manufactured from them. They also relish dried animal matter such as dead insects, including the dead of their own species, and untreated skins, beef meal, casein, etc. In experimental work clothes moths have thrived best upon a diet of bristles, hair, feathers, fur, or raw wool, and not so well upon ordinary woolen cloth used in the making of wearing apparel. Notwithstanding this, the damage they cause to wearing apparel has given them a well-deserved reputation as pests. There may be some satisfaction, however, in knowing that if the death rate among clothes moths feeding upon dyed woolen fabrics was as low as among those feeding upon raw wool, and their growth as rapid as when they feed upon bristles, fur (Figs. 11 and 12), and hair, their capacity for destruction would be increased enormously. When a campaign is waged against clothes moths in the home, it must be remembered that they may be found feeding upon carpets and rugs

FIG. 7.—Tapestry moth: Adult. Enlarged. (Riley.)

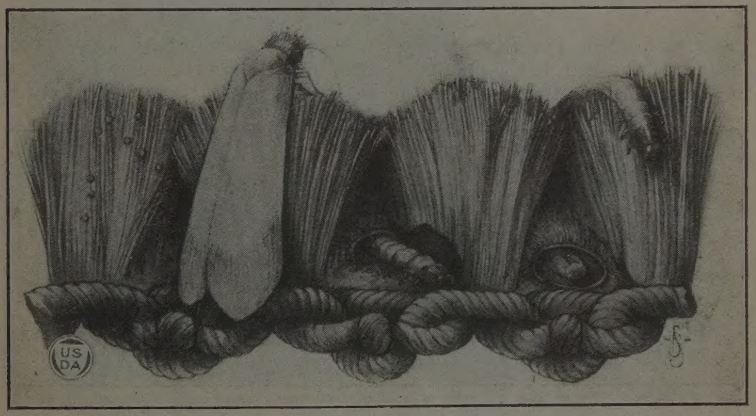

FIG. 8.—Clothes-moth injury to carpet: Side view of carpet showing moth, with eggs on tuft, to left, larva eating at base of tuft to right, and cocoon with end cut to expose pupa within. Note larva crawling over tuft at extreme right. Greatly enlarged.

(Figs. 8, 9, and 10), stuffing and covering of upholstered furniture, tapestries, stuffed animals or birds, dust brushes (Fig. 13), shaving brushes (Fig. 14), the felts in pianos, and a long array of articles often little thought of as being fed upon by clothes moths. A single piece of hair-stuffed or feather-stuffed furniture may keep a house well stocked with clothes moths for years. Clothes moths almost never injure household fabrics or wearing apparel in daily or weekly

use, or articles that are brushed, cleaned, or beaten once or twice a month. Furniture, on the other hand, may be in constant use and still be badly infested.

BIOLOGY OF CLOTHES MOTHS.

It is important in a fight against clothes moths to know something about their biology. Each generation is called a life cycle because

FIG. 9.—Clothes-moth injury to rugs. When the injury illustrated above has progressed sufficiently far, whole patches of pile are cut off by the larvæ and the warp is left exposed as here shown. Sometimes larvæ feed on the underside of carpets and rugs, but they cut the pile there just as in feeding as indicated in Figure 8.

the insect keeps passing through a successive round of stages, consisting of the egg, the larva, the pupa, and the moth. The following facts concerning these stages of the life cycle relate particularly to

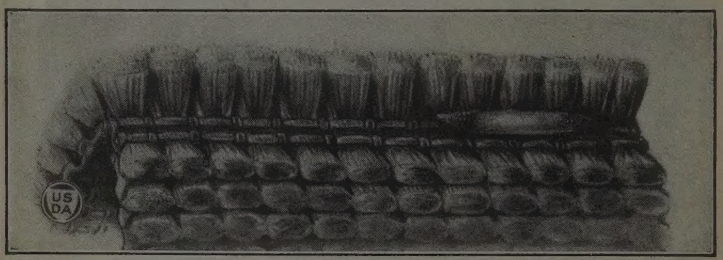

FIG. 10.—Clothes-moth infestation in rugs and carpets can be detected by bending the fabrics so that the space between the tufts of pile can be examined. Moth webbing and cocoons (as here shown) are thus readily exposed.

the webbing clothes moth, but must be taken into consideration in any intelligent campaign against clothes moths of other species as well.

THE ADULT OR MOTH MILLER.

The moth, or "miller," which is the adult, seldom lives as long as one month. Moths are more likely to die between the seventh and fourteenth days after they emerge from the pupa. Apparently they

take no nourishment, and the female moths begin laying eggs before they are fully one day old and usually lay eggs each subsequent day of their lives. When a moth stops laying eggs it is a sign that she will die within a day or two. Few moths have been known to lay over 150 eggs, and of this number at least one-half are laid during the first few days of adult life. As many as 59 eggs have been laid during 24 hours by one female moth, but this is an unusual number.

THE EGG.

The eggs are laid singly or in groups of as many as 25, either loosely upon or between folds of fabrics. In loosely woven goods,

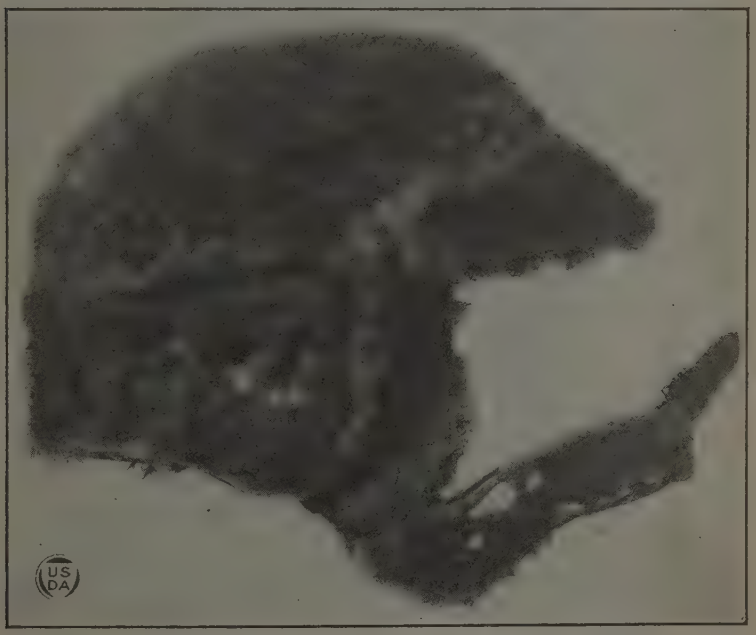

FIG. 11.—Aviator's helmet slightly damaged by webbing clothes moth larvæ. Compare with Figure 12, which shows complete destruction of fur.

such as yarns, carpets, and rugs with heavy nap, or heavy woolen clothes, the eggs are placed down in the meshes of the fabric, where they are held by the fine threads, as illustrated in Figure 15. On certain closely woven serges they are laid so loosely upon the surface that they can be shaken off. In furs, the female moth may burrow down among the hairs to the skin itself in order to find a sheltered place for her eggs. The eggs are not as large as the head of a common pin, but, small as they are, their white color makes it possible to see them without the aid of a magnifying glass, if they are laid upon a dark or black substance. They are very fragile and easily crushed.

Clothes-moth eggs hatch most readily in warm summer weather in from four to eight days. During colder weather hatching may not take place for three weeks. In steam-heated buildings hatching does not require a much longer time than that taking place in warm summer weather.

THE LARVA.

Of all the stages, the larva or worm stage—the only stage in which clothes moths damage fabrics—is the most susceptible to outside influences upon its growth. The nature of its food, the temperature,

FIG. 12.—Aviator's helmet with fur completely eaten away by larvæ of webbing clothes moth. Note cocoons of moth on upper portion, and that the larvæ have even eaten the leather on central lower portion.

and the humidity have pronounced effects. Sometimes, for no apparent reason, the larva may pass into a period of dormancy lasting as long as 8 to 10 months, during which it will neither feed nor move about appreciably, only later to become active, feed, and continue its growth.

When first hatched the larva is white, as when full-grown, and is scarcely one-sixteenth of an inch long. When young it is so transparent that the color of its food shows through its alimentary canal as a line extending along the center of the body. When full-grown it may be half an inch long, although its size will vary with its environment and food supply. It is not possible to judge the age of a larva by its size. Some larvæ at 15 months of age are very

much smaller than others only 2 months old. The shortest definite record for larval development known is 104 days during warm summer weather at Washington, D. C.

Many larvæ hatching during the summer do not become fully grown and mature as moths until the following March, April, and May. There even is a considerable variation in the length of time larvæ of the same brood require for development. Larvæ hatched on

FIG. 13.—End view of common bristle dust brush, showing sandlike pellets of frass and damaged bristles. Clothes moths can feed upon all articles made of bristles.

the same day may require as few as 15 weeks or as long as 2 years. Much depends upon their food and environment.

THE PUPA OR CHRYSALIS.

The pupa or chrysalis stage lasts during warm summer weather about eight days. During the winter months from January to March, in a steam-heated building, clothes moths remained in the pupa stage three to four weeks.

SEASONAL HISTORY.

While moths may be on the wing in steam-heated buildings during almost any month, they are present in greatest abundance the country

over from May to July and during September and October. In steam-heated houses moths of the webbing species have been observed as early as late December, January, and February. In northern localities, where only the case-making moth is present, and in houses not continuously heated, the moths are single-brooded and appear during late May, June, and July. The late appearance of moths in such northern houses is greatly to the advantage of the housewife, for by June winter clothing can be stored where it is protected from moth eggs.

While it is true that wearing apparel is not damaged by clothes moths if in daily or weekly use, the occasional appearance of moths

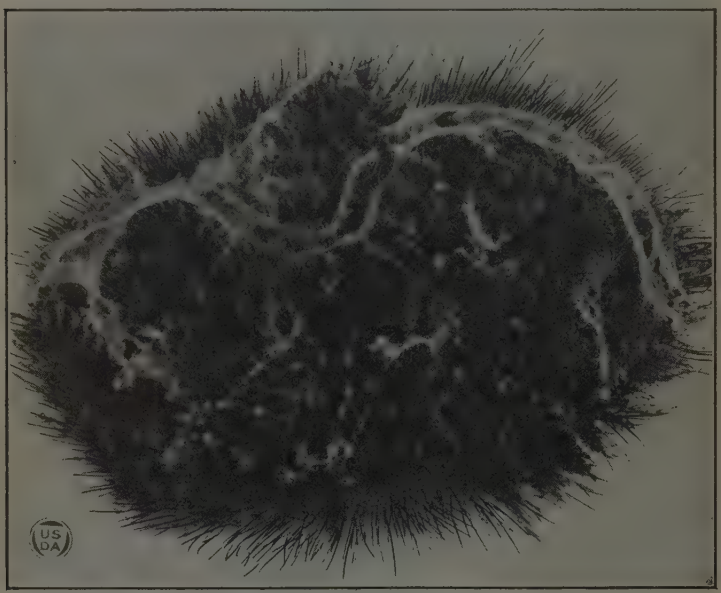

FIG. 14.—End view of shaving brush, showing a well developed larval tube of the southern or webbing clothes moth.

in steam-heated houses in late winter makes it clear that moth eggs may be laid on susceptible articles at any time they are not in use and that if laid away without precautionary measures being taken to safeguard them they may be quite unexpectedly damaged in storage.

REMEDIES RECOMMENDED.

There are effective methods for the control of fabric pests by the use of which the losses due to them can be reduced to a minimum. The fumigation of houses is not feasible or necessary for all, but careful attention to the details of cleaning, brushing, and, if possible, to sunning of fabrics immediately before they are stored with naphthalene or paradichlorobenzene or wrapped tightly in paper

with these crystals is an effective and inexpensive remedy within the reach of everyone. Various effective remedies are enumerated here, together with a statement regarding conditions under which they are most effective.

The remedies here listed for the killing of fabric pests, or for protection against them, have been thoroughly tested and are in general use by the public. They can be recommended without reservation if used with an intelligent understanding of their good or bad features and in accordance with directions.

(1) Constant watchfulness. This must be the watchword for successful control. No treatment known to kill clothes moths already in fabrics will have any lasting effect in keeping other clothes moths from infesting the fabrics later if they are left exposed about the

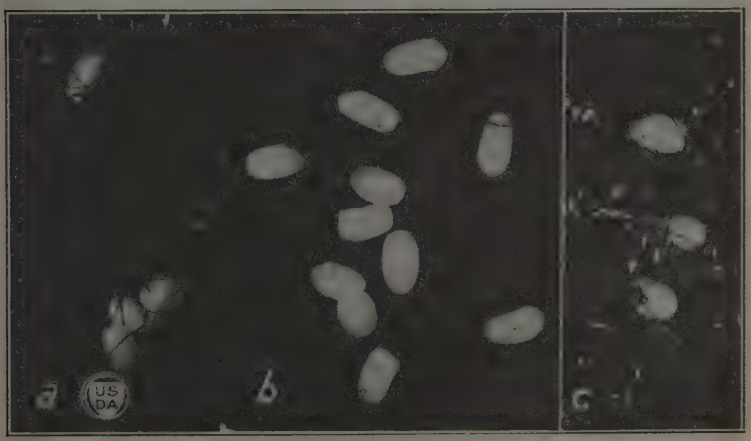

FIG. 15.—Eggs of webbing clothes moth: At *a* and *c*, laid among the threads of a loosely woven cloth; at *b*, laid upon a closely woven broadcloth. Greatly magnified.

house. There is no treatment known that is practical that will render wearing apparel absolutely immune to attack.

(2) Thorough brushing, beating, and, if possible, sunning fabrics before any treatment is applied. These are important under all circumstances.

(3) Careful wrapping in unbroken paper.

(4) Naphthalene. Very effective in the form of flakes or moth balls for protecting clothing in closets, trunks, and tight chests.

(5) Paradichlorobenzene. Equal in effectiveness to naphthalene and used in the same manner.

(6) Camphor. For use in tight chests and trunks, but not as good as Nos. 4 and 5.

(7) Pyrethrum powder. Not as good as Nos. 4, 5, and 6.

(8) Cold storage. Rather expensive, but a certain method of protection against clothes-moth injury during the period in storage.

(9) Hydrocyanic-acid gas. Excellent for fumigating entire houses or single *tightly sealed* rooms, but dangerous except when applied by an expert or careful and well-informed person.

(10) Sulphur fumes. Sulphur fumes generated by burning sulphur candles, purchased at drug stores. Likely to bleach wall paper and fabrics and will tarnish metals.

(11) Carbon disulphid. Excellent for fumigation of closets which can be tightly sealed, trunks, chests, and other tight containers. The gas is inflammable.

(12) Carbon tetrachlorid. Excellent for fumigation of single rooms, closets, trunks, chests, and other tight containers.

(13) Cedar chests. Excellent for protecting clothing if used according to directions.

(14) Dry heat. Dependable if it can be applied.

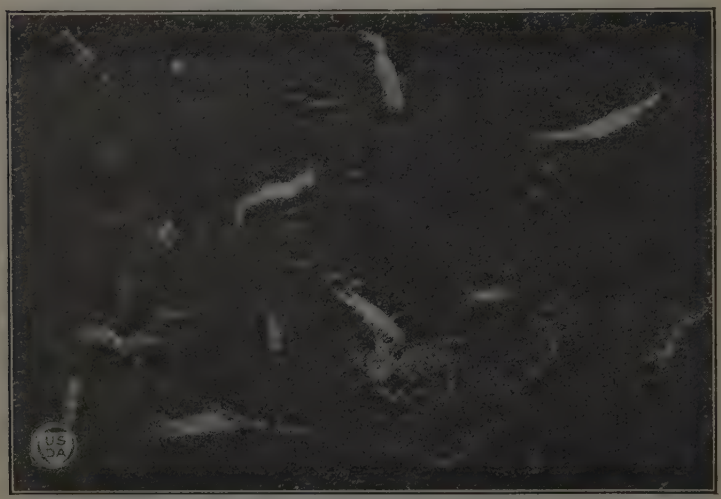

FIG. 16.—Piece of flannel from which the nap has been entirely eaten away by larvæ of the webbing clothes moth. Note collapsed larval tubes scattered above cloth. Feeding of larvæ often does not extend beyond the surface of the fabric.

(15) Hot water.

(16) Soap solution.

(17) Treatment of cracks and hiding places with gasoline, benzine, and kerosene.

(18) Dry cleaning.

BRUSHING, BEATING, AND SUNNING.

Too much emphasis can not be placed on the value of frequent brushing, beating, sunning, and cleaning of articles subject to clothes-moth attack. The eggs of clothes moths are delicate and can usually be crushed or dislodged by brushing and beating. Pay special attention to crevices, seams, and pockets. Sunning is a valuable aid in control work. In articles laid away moths are much more likely to concentrate upon soiled spots if these have not been re-

moved. Brushing and beating usually remove or kill the larvæ or worms. If clothing is thoroughly brushed every two weeks, it is doubtful if moths can affect it seriously. Carpets and rugs cleaned by strong vacuum cleaners and thoroughly brushed on both sides, or electrically cleaned, are freed from infestation if the work is properly done. Clothing dry-cleaned is also freed from infestation by the process. Once freed from infestation, clothes should be protected, if they are not to be used during the warm season, by being wrapped in paper or placed in tight chests or treated closets.

CAREFUL WRAPPING IN UNBROKEN PAPER.

The public is familiar with "moth-proof" paper bags of various types that appear upon the market each summer. These paper bags for the storage of suits and coats are made of heavy paper, paper impregnated with tar, or other substances for which much is claimed. These bags if not torn and if properly used are excellent for keeping moths from reaching clothing. They are of no value in killing moths that may be in the clothing when it is placed in the bag, and those made of plain paper are just as good as those containing tar.

The value of such bags as protectors against infestation ceases largely as soon as they are torn, even slightly, or are left unsealed. Frequently clothing on coat hangers is placed in bags with the hook of the hanger protruding from the bag so that the clothing and bag may be hung in the closet. Unless special attention is given to this method of hanging, the paper bag is not carefully sealed about the hanger, and spaces of one-fourth inch or more are left open. Moths have no difficulty in crawling into such openings, and if they find them the bags are useless.

Ordinary firm wrapping paper is satisfactory, or several thicknesses of newspapers will serve. Clothes moths do not eat into paper to reach clothing. For this reason, if woolens and other fabrics subject to moth attack are cleaned and freed from moths by any of the methods mentioned above, they will remain safe if wrapped at once and tightly in several thicknesses of firm wrapping paper or in newspapers. There is a general belief that the print on newspapers keeps moths away. This is not true. Any paper of moderate thickness and unbroken will protect clothing. Care must be exercised to bend back the folds of the paper upon themselves at the ends of the bundles so that the moths can not crawl into the bundles at the ends. Hats and other articles that will be damaged by tight wrapping can be protected by placing them in ordinary *unbroken* cardboard boxes, hat boxes, etc., and then sealing the covers of the boxes with gummed paper.

After clothing has been made into bundles or sealed in boxes, these bundles and boxes may be left exposed in garrets or on storeroom shelves without danger of infestation from without. If flake naphthalene is wrapped among the folds of clothing made into bundles, any small larvæ that may have got into the cloth before it was wrapped will be killed.

NAPHTHALENE.

Naphthalene, in the form of "flakes" or "moth balls," commonly for sale at drug stores, is a well-known substance. Naphthalene in good condition is one of the safest and best materials for protecting fabrics against moth injury. To get definite results it must be used in tight chests, trunks, or other containers where the fumes given off by the slow evaporation of the crystals will be confined. If used in bureau drawers, in closets frequently opened, in pockets of clothing hung in closets, or in boxes which permit the fumes to escape, naphthalene is only partly effective and can not be depended upon for absolute protection. Naphthalene can be purchased of chemical firms in tin cans containing from 1 to 10 pounds or more, and if so purchased one is sure of getting good material if dealing with a dependable firm. The fumes of naphthalene will not injure man, as he is ordinarily subjected to them. Naphthalene flakes and balls cost from about 15 to 20 cents a pound.

Naphthalene should be used at the rate of about 1 pound to each 6 to 10 cubic feet of space. One pound of good naphthalene flakes scattered between the folds of clothing in a trunk of average size should kill all stages of clothes moths. In tight chests of ordinary size the fumes given off by the slow evaporation of 1 pound of naphthalene will kill both young and well-grown larvæ of clothes moths and prevent moth eggs from hatching. If a good grade of naphthalene is used in tight containers there is no doubt as to the efficiency of naphthalene fumes. Too many persons expect naphthalene scattered about closet shelves or bureau drawers to be effective. It is not entirely so under such circumstances. If chests or trunks are not very tight much can be done toward making them so by sealing the cracks with adhesive paper or by papering them on the inside. If there is opportunity for the fumes to escape, use from 2 to 3 pounds of naphthalene to each 6 to 10 cubic feet of space.

PARADICHLOROBENZENE.

Paradichlorobenzene is a white crystalline substance, which vaporizes slowly at ordinary temperatures, forming a gas apparently heavier than air. This gas is nonpoisonous to man, but poisonous to clothes moths and other fabric pests when they are exposed to it in tight containers. The fumes do not injure fabrics. Paradichlorobenzene is similar in general appearance to naphthalene flakes. It can be purchased in tin cans containing from 1 to 10 pounds, from drug stores or direct from the manufacturing chemists, at a cost of from 15 to 45 cents per pound, according to the quantity purchased. It appears to be quite as effective as naphthalene when used in accordance with directions for the use of naphthalene, and in the same amounts. It is a relatively new remedy which bids fair to become as well known in moth control as naphthalene.

CAMPHOR.

Gum camphor is used in the manner recommended for naphthalene and paradichlorobenzene, but is less effective than naphthalene. If of good quality and used at the rate of from one-half to 1

pound to each 5 cubic feet of space in tight containers, gum camphor will protect. All stages of clothes moths are killed by the fumes given off by the camphor; hence camphor, to be most effective, should be broken into small pieces and used in tight containers which will confine the fumes. While gum camphor does kill some eggs and larvæ when sprinkled in small pieces upon infested cloth in open containers such as bureau drawers, pockets in clothing, etc., it is not to be depended upon except where the fumes given off by evaporation can be closely confined with the clothing to be protected.

PYRETHRUM POWDER.

Pyrethrum powder, if fresh, will kill clothes-moth larvæ. Clothing should be thoroughly dusted with the powder and placed in a

FIG. 17.—View in cold storage room for rugs and carpets in a modern fireproof storage warehouse. Rugs and all other articles subject to attack by fabric pests are absolutely protected while in cold storage.

tight container such as a chest or trunk, or wrapped well in unbroken paper. Pyrethrum powder soon loses its protective value on exposure to air, hence is not considered particularly effective for long storage, and is inferior to naphthalene or paradichlorobenzene. It is not always easy to obtain fresh pyrethrum powder at stores.

COLD STORAGE.

The best method of protecting against injury by fabric pests of all kinds is cold storage. It is the best method because it eliminates all error on the part of the owner. Once in cold storage no injury can take place. Cold storage (Fig. 17) is depended upon for absolute protection by dealers in carpets, furs, and other valuable articles such

as stuffed animal heads, blankets, carriage robes, curtains, and upholstered furniture. Cold-storage facilities have increased with public demand until to-day no city or large town is without storage equipment. A tour during the summer months through the cold-storage rooms of large department stores and storage concerns with their wealth of furs and woolens can not but impress one with the well-grounded faith of the public in this means of protection.

Articles will be protected from injury in storage at temperatures ranging from 40° to 42° F. A number of years ago a manager of a large storage warehouse company in Washington, D. C., conducted certain experiments at the instance of the Chief of the Bureau of Entomology, with the result that it was found that larvæ of the webbing clothes moth and of the black carpet beetle can withstand for a long time a temperature of 18° F. It has been discovered that it is not so much the cold that kills. It is the sudden change from a cold to a warmer temperature and back to a cold temperature that most quickly results fatally. Thus it was learned that if articles infested with clothes moths were refrigerated at 18° F. for several days, then suddenly exposed for a short time to 50° F., and then returned to 18° F., and finally held permanently at about 40° F. all moth life in them would be killed.

If storage concerns aim at the destruction of clothes moths in articles intrusted to them, as well as the protection from injury of these articles during the period of storage, it is recommended that articles be exposed to two or three changes of temperature as noted above before they are placed permanently at 40° to 42° F. The maintenance of a temperature lower than 40° to 42° F. is needless and a wasteful expense.

If the storage company merely guarantees to protect articles during the period of storage, it is quite sufficient to maintain them at a temperature of about 40° to 42° F. Companies should advise patrons that clothes-moth larvæ can withstand prolonged storage at temperatures ranging from 24° to 45° F. for longer periods than that for which the majority of articles are refrigerated. Thus well-grown larvæ of the webbing clothes moth in fur and wool were held in commercial cold storage at a temperature said to fluctuate between 24° and 48° F., but held mostly at about 40° F., and were found by the writer to be alive after storage for 6, 8, 10, 11, and 12 months. Larvæ in fur helmets placed in storage during February, removed the following December, and held in a steam-heated building, transformed in considerable numbers into active adults by the middle of January. These adults showed no effects of the refrigeration of the larvæ from which they had developed, but laid many eggs that hatched normally. Refrigeration for six months had no noticeable effect upon the larvæ, except to hold them inactive and incapable of causing injury. While larvæ refrigerated for 10 to 12 months matured, as above stated, into moths, a large percentage, though active soon after removal from storage, died after being subjected to warmer temperature. These facts are important, for they explain why patrons have at times found living, active, and robust larvæ in articles several days after removal from 4 to 5 months in cold storage. If a fairly even temperature has been maintained, such a discovery is to

be expected. If articles are cleaned thoroughly before being placed in storage of any sort, as they always should be, the likelihood that they will contain well-grown larvæ is very slight.

FUMIGATION OF ENTIRE ESTABLISHMENT WITH HYDROCYANIC-ACID GAS OR SULPHUR FUMES.

In large houses with many carpets or rugs, much upholstered furniture (Fig. 18), and other fabric furnishings, and in tourist hotels and houses used only during the winter months but closed through the long, hot summer season, fabric pests may become very abundant and so generally established that they can not be reached

FIG. 18.—End of couch with covering removed to expose work of clothes moth and carpet beetles. Note that the hair stuffing has been nearly eaten up, while on the inside of the leather are many cocoons of the webbing clothes moth. Fumigation with hydrocyanic-acid gas is very effective in killing insects in furniture of this type.

easily by the more local treatments recommended further on. In such establishments insects may not only be secreted in the affected furnishings, but may be upon the walls, in floor cracks, behind mopboards, and in other places where they have crawled for protection or for transformation. The removal of furnishings and their treatment outside the establishment, or in special rooms, will remove at the same time most of the infestation, yet enough insects may be left behind to restock the furnishings when they are returned after treatment. For this reason, any control measure that can be applied to the house or hotel with the furnishings left as they are normally has its advantage. Exception should be made in the case of chests or other tightly packed containers. Clothing, blankets, and other contents of such containers should be removed and hung up in

rooms or variously spread out over furniture, etc., so that fumes can more readily reach the larvæ in them. This need not be done if the containers are treated as separate units as hereinafter suggested. It may be well to raise rugs or carpets so that the gas can more easily reach the underside, though this is not always necessary or feasible. The tops of pianos and organs (upon the felts of which the moths and carpet beetles may be feeding) should be raised, and all closet doors, bureau drawers, trunks, etc., should be left partially open.

Fumigation by two methods can be used for the treatment of houses or hotels as a single unit—namely, with hydrocyanic-acid gas and with sulphur fumes. *Formaldehyde fumigation is worthless for control of clothes moths or other fabric pests, notwithstanding general belief.* It is a good disinfectant for use after contagious diseases, but should never be employed for controlling fabric pests.

HYDROCYANIC-ACID GAS.

Fumigation with hydrocyanic-acid gas is the best known method of controlling fabric pests as well as other household pests, including the bedbug. It kills speedily and effectively. The gas is formed by the union of sulphuric acid, sodium cyanid or potassium cyanid, and water. It is colorless, lighter than air, with a distinct odor, and when mixed with air in the proportion occurring during fumigation is noninflammable. It is not injurious to the most delicate fabric or dyes, or to any house furnishing, and does not tarnish silver, brass, or other house metals. When the house is ventilated, the gas quickly escapes skyward, and houses usually can be ventilated so that they may be occupied within 1 or 2 hours' time, often within 30 minutes. Sleeping quarters at hospitals, and private homes, can be fumigated during the day and ventilated so that they can be safely occupied the same night.

Hydrocyanic-acid gas is deadly to humans if breathed in concentrated form, and should be used only by an intelligent, careful, and well-informed person who understands the element of danger as well as the excellent features of the gas. Hydrocyanic-acid gas should not be used in an apartment house, office building, or city block of houses unless neighboring parties are notified and are ready to vacate if necessary during the period of fumigation. Hydrocyanic-acid gas fumigation costs approximately 35 to 50 cents for each 1,000 cubic feet of space fumigated. The house may be left exposed to the action of the gas for from 4 to 24 hours. Hydrocyanic-acid gas fumigation is being employed in flour mills, warehouses, leading hospitals, schools, and colleges, as well as in private homes. For information on the method of fumigating with hydrocyanic-acid gas write to the United States Department of Agriculture at Washington, D. C., for Farmers' Bulletin 699.

SULPHUR FUMES.

Fumigation with sulphur fumes is a remedy well known to the public. Sulphur fumes will kill clothes moths, but must be used at the rate of about 13½ ounces of sulphur to each 1,000 cubic feet of

space. Fumigation should continue for a period ranging from 18 to 24 hours. *Remember* that there is some danger of fire in the careless use of sulphur candles; also that sulphur fumes may have a bleaching effect upon delicate fabrics and wall paper, and that they tarnish metals. The greater the atmospheric moisture the greater the bleaching effect. The Department of Agriculture does not recommend the use of sulphur fumes in homes equipped with valuable furnishings. Very often, however, the use of sulphur candles offers a most welcome method of moth control, because of the availability of sulphur candles at drug stores. Naturally where fumes are used rooms or houses must be tightly closed and more rather than fewer of the sulphur candles used. Failure with sulphur candles often is the result of dependence upon one or two improperly burned candles to do the work of the recommended 13½ ounces of sulphur for each 1,000 cubic feet of space to be fumigated. Directions for burning sulphur candles usually are supplied by the manufacturer or the dealer.

CARBON DISULPHID FUMIGATION.

Carbon disulphid is an excellent fumigant for single rooms, closets (Fig. 19), trunks (Fig. 20), chests, and other tight containers. It is sometimes called "high-life," and can be purchased at drug stores or from wholesale chemical firms as a liquid put up in tin cans of 1, 2, 5, 10, or more pounds capacity at a cost of from about 6 to 35 cents a pound, according to the quantity used. It is a colorless [8] liquid that looks like water, but weighs about 10 pounds to the gallon. When exposed to the air it evaporates quickly, producing a foul-smelling gas about two and three-fourths times as heavy as air. While the liquid is not explosive or inflammable, the gas formed upon evaporation is. Because of this inflammable nature of the gas it must be kept away from fire in any form. The gas can be detected easily by its foul odor, but this odor disappears after thorough ventilation of rooms and fumigated articles. If used carefully and intelligently as directed and in the proper amounts carbon disulphid speedily and surely kills fabric pests in tight containers. It is not recommended for the fumigation of entire buildings because of the fire hazard when so great a volume of gas is formed, although experienced persons can use it safely for the fumigation of detached houses if they can control surrounding conditions.

When used in small amounts about houses in accordance with directions, there is but little more danger than in the use of gasoline or benzine, with which the public is more familiar. For complete information regarding carbon disulphid and its use, write to the United States Department of Agriculture for Farmers' Bulletin 799.

Fumigation with carbon disulphid is not effective at temperatures below 65° F. Better results follow where the temperature is above 70° F. In rooms and closets or in well-built trunks the evaporation from 4 to 6 pounds of the liquid to each 1,000 cubic feet of space should kill all moths and their larvæ. If the walls are plastered, or

[8] The ordinary commercial carbon disulphid has a decidedly yellowish color, due to the excess of sulphur.

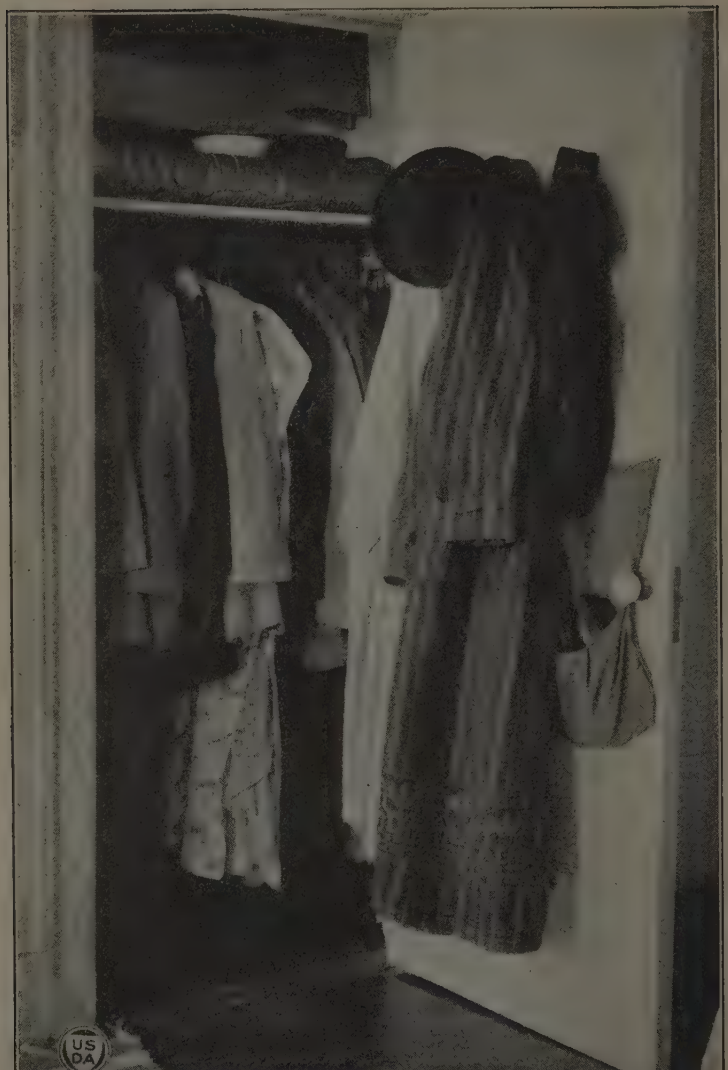

FIG. 19.—Clothing in closets can be freed of clothes moths if fumigated as illustrated with either carbon disulphid or carbon tetrachlorid. Since the gas formed by evaporation of these two liquids is heavier than air, pour the liquid into a shallow dish placed on the shelf of the closet. (Note white enameled dish on shelf.) For a closet 2 by 5 by 7 feet use about three-fourths of a cup of carbon disulphid or about 1¼ cups of carbon tetrachlorid. As soon as liquid has been poured into dish shut door and seal cracks about door with gummed paper, or paste on strips of firm paper, using a flour paste. Sealing the door prevents the gas from escaping rapidly and keeps clothes moths from crawling into the closet by way of the cracks and offsetting the good of the fumigation.

plastered and papered, the floors tight, and the doors sealed after fumigation begins, 4 pounds of carbon disulphid should prove sufficient to kill fabric pests. More liquid, even as much as 20 pounds per 1,000 cubic feet of space, may be required in more loosely constructed containers. Assuming that 4 pounds of carbon disulphid will be used to each 1,000 cubic feet of space, the following rough calculations may be useful in determining how much liquid is needed for various containers:

Quantities of carbon disulphid needed for fumigation.

Space to be fumigated.	Quantity needed.
Room, 12 by 10 by 8 feet	4 pounds or 3¼ pints.
Closet, 3 by 8 by 8 feet	1½ pints.
Closet, 2 by 5 by 7 feet	¾ cup.
Closet, 4 by 5 by 7 feet	1½ cups.
Trunk, 21 by 20 by 42 inches	3 tablespoonfuls.
Box, 1 by 2 by 2 feet	1 tablespoonful.

Note that the method of application, as indicated in figures 19 and 20, takes into consideration the fact that the gas formed is about two and three-fourths times as heavy as air. The liquid must therefore be exposed on top of the article to be fumigated.

CARBON TETRACHLORID FUMIGATION.

Carbon tetrachlorid is a good fumigant for single rooms, closets, trunks, chests, and other tight containers. It is a thin, transparent, colorless liquid, in appearance similar to water, that evaporates on exposure to air, forming a gas with a pungent, aromatic odor. It is like carbon disulphid in that its gas is heavier than air. When carbon tetrachlorid is used at the same rate as carbon disulphid, it is about one-half or one-third as effective. It has the great advantage over carbon disulphid that its gas is neither explosive nor inflammable, hence there is no fire risk in its use. Carbon tetrachlorid is purchased at drug stores or from chemical firms in cans containing 1 or more pounds of liquid, and costs from 10½ to 30 cents a pound, according to the quantity purchased. It should be used at the rate of 8 to 12 pounds, or more, per 1,000 cubic feet of space if containers are very tight. When the temperature is 70° F. or above, good results in killing clothes moths should follow if the quantities given above for carbon disulphid for the respective spaces are trebled. Since the gas is heavier than air, the liquid should be exposed in shallow dishes at the top of the container to be fumigated. (See Figs. 19 and 20.)

CEDAR CHESTS.

Chests made of the heartwood of red cedar,[9] such as are found on the market (Fig. 21), not only are so tightly constructed that the moths can not enter them when closed, but the aroma of the wood kills the newly hatched or young larvæ of the clothes moths. If in good condition as regards tightness, therefore, cedar chests are effective in protecting fabrics from clothes-moth attack when pre-

[9] *Juniperus virginiana.*

cautions are taken to beat, brush, and, if possible, sun the articles before they are placed in the chest.

The aroma, or the persistent characteristic odor, of red cedar, is due to a volatile oil present in the wood to an amount ranging from 1 to 2 per cent. The redwood or pure heartwood of red cedar contains from 2 to 4 per cent of this oil.[10] As it is the aroma from this volatile oil in the wood that protects clothing, the chests at all times should

FIG. 20.—Trunk ready for treatment with carbon disulphid or carbon tetrachlorid. On the clothing are shown two saucers. In the one to the left stands a 1-pound tin can of carbon disulphid; in the one to the right a glass bottle filled with the colorless carbon tetrachlorid. For the fumigation of a trunk 21 by 20 by 24 inches, pour about 3 tablespoonfuls of carbon disulphid liquid into the saucer and close and seal the trunk. If carbon tetrachlorid is used, pour at least 6 to 10 tablespoonfuls of liquid into a saucer, close, and seal. The liquid evaporates, forming a gas heavier than air that sinks down into the clothing and kills clothes moths and other insects.

remain tightly closed except when clothing is being removed or placed in them, and this work should be done as rapidly as possible.

The average trunk in which clothing is stored is not tight enough to keep out moths. Indeed, the unusual tightness of cedar chests, when not cracked or warped, compared with ordinary trunks or other

[10] The principal constituents of the oil are the alcohol cedrol or cedrol camphor, the sesquiterpene alcohol cedrenol, and the sesquiterpene cedrene. The characteristic odor of cedar chests is probably due to the first two compounds mentioned.

Fig. 20, line 4, dimensions of trunk should read, "21 by 20 by 42 inches."

ordinary household receptacles for clothing, gives to such chests a great advantage, in addition to their definite insecticidal value.

The value of cedar chests in protecting clothing lies in the fact that they kill the newly hatched or young larvæ or worms of clothes moths. Cedar chests can not be depended upon to kill the moths or millers, their eggs, or the worms after they are one-half to full grown or after they are 3 or 4 months old. Neither will the chests kill all the pupæ or chrysalids. It is because they will not kill these

FIG. 21.—Red cedar chests are among the best chests upon the market for the protection of clothing from clothes moths, provided they close tightly and directions for their use given in this bulletin are faithfully followed.

stages of the clothes moth that cedar chests are recommended as protectors of clothing from moth attack only when fabrics put into them are thoroughly cleaned, brushed or beaten just before they are placed in the chests. This preliminary treatment before storage, if carefully done, with special attention to brushing out pockets, seams, etc., will remove those stages of the moth that the chests will not kill. Remember that if clothing is not thus brushed, etc., with scrupulous care, some of the older larvæ may remain and go into the chests with the clothing and continue to cause damage.

Furs can not always be rid of these older worms by merely brushing or beating. Clothes moth worms often lie hidden next to the

skin and are so firmly established by the webbing they spin that they are not dislodged from the fur by brushing or shaking. For this reason furs suspected of being infested should be combed out with a very fine comb, or should be fumigated. If furs are promptly stored as soon as the season for their use is over, however, there is little likelihood that they will contain moth larvæ too old to be killed by the chests.

It is a matter of no practical importance whether cedar chests kill the moths, the eggs, or the pupæ, for these stages are not capable of injuring garments. But too much can not be said about the necessity of making sure that clothing going into cedar chests is free from the older larvæ or worms; otherwise the owners may sustain losses attributable to carelessness, rather than to the failure of the chest.[11]

DRY HEAT.

Heat is now recognized as an effective agent in killing insects. All fabric pests will be killed in a very short time if rooms can be heated to a temperature of 130° F. long enough to permit all articles in the room to be thoroughly heated through to this temperature. Experimental work has demonstrated that even lower temperatures will kill the larvæ of clothes moths. All larvæ exposed in an incubator to 128°, 120°, and 110° F. died in 6, 11, and 31 minutes, respectively. At 105° F. 20 per cent were dead at the end of 31 minutes, while at 110° F. 30 per cent were dead at the end of 11 minutes. This killing power of heat can be readily utilized by ironing fabrics with very hot irons, or exposing them in superheated rooms before they are put away for the summer.

The rays of the sun in summer can often be used to kill or drive clothes moths from fabrics. Thus clothes-moth eggs on flannel, exposed to the bright sun at 128°, 125°, 120°, and 110° F., were killed at the end of 6, 6, 11, and 31 minutes, respectively. Exposure to the sun at 110° and 105° F. for 31 and 11 minutes, respectively, did not kill the eggs. Well grown larvæ of clothes moths in garments exposed for several hours to the hottest rays of the sun usually become restless and spin down from the garment. The old-time custom of sunning clothing to kill moths is based upon excellent experience.

HOT WATER.

Water boils at 212° F. At 115° a person finds water almost too hot to hold his hand in it. Fabrics that will not be injured by water can be freed of living clothes-moth eggs and larvæ by being dipped for 10 seconds in water heated to 140° F. Care, however, must be exercised to have and keep the water at this, or a greater, temperature. Larvæ and eggs in flannel dipped for 10 seconds in water heated only to 122° F. remained unaffected.

[11] The foregoing statements regarding the effect of red-cedar chests on adults, eggs, and larvæ of clothes moths are based on a comprehensive study by the Bureaus of Entomology and Plant Industry of the United States Department of Agriculture. The results of this study are reported in Department Bulletin 1051, Red Cedar Chests as Protectors Against Moth Damage, by E. A. Back and Frank Rabak, published in 1922. Copies of this bulletin may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 10 cents each.

LAUNDRY SOAP.

Clothing washed with a strong solution of neutral laundry soap will be freed from clothes-moth larvæ and eggs, and if wrapped tightly in paper, as suggested on page 15, as soon as taken from the drying line, will remain free from moth attack.

TREATMENT OF CRACKS AND HIDING PLACES WITH GASOLINE, BENZINE, OR KEROSENE.

Any effective method of control for clothes moths and other fabric pests must take into consideration the fact that woolen lint, hair, etc., accumulate in floor cracks, behind base boards, and in other such places. In this "dust" carpet beetles and clothes moths can and do subsist and migrate thence to other parts of the house. It is desirable, therefore, to reduce these hiding places as much as possible by the use of crack fillers such as can be purchased at paint shops, and treating them with kerosene, gasoline, or benzine. *Persons are warned against the careless use of these three liquids because of their inflammable nature.* If the premises are fumigated, clothes moths and other fabric pests in floor cracks and similar places are killed and the more laborious treatment by liquids is not necessary.

IMPRACTICAL OR WORTHLESS REMEDIES.

Below are listed certain worthless remedies, besides others not recommended to the housewife because of difficulty of application, partial effectiveness, impracticability, or lack of full information regarding their value.

WORTHLESS SUBSTANCES.

The following substances often recommended for clothes-moth control are worthless:

Tobacco extracts containing nicotine and tobacco powder when used at reasonable strengths.
Lavender flowers (scattered on).
Cayenne pepper.
Allspice (dusted).
Angelica root (dusted).
Black pepper.
Pyrethrum stems (dusted).
Lime, air-slaked (dusted).
Powdered sulphur (dusted).
Salt (dusted).
Quassia chips (dusted).
Borax (dusted).
Colocynth pulp (dusted).
Eucalyptus leaves (dusted).
Hellebore, white (dusted).
Formaldehyde (sprayed 1 to 10).
Sodium bicarbonate (dusted).
Sodium carbonate (dusted).
Lead carbonate (dusted).
Lead oxid (dusted).
Red cedar leaves (dried and placed in clothing).

IMPRACTICAL REMEDIES.

The following substances have considerable value if fresh or properly used, but they are impractical for one or more reasons and are not recommended, especially as among the remedies that can be recommended very highly there are a number that are easily within the reach of all.

Cedar chips and cedar shavings.—Ordinarily only partially effective, and never effective against adults or the half-grown to full-

grown larvæ of clothes moths and carpet beetles. They soon lose their value and often become valueless before they are purchased by the retailer. Since the average purchaser of cedar chips and shavings has no certain method of determining their strength, it is better not to depend upon them than to secure weak material and suffer loss from moths.

Gasoline.—Gasoline sprayed on flannel killed clothes-moth eggs. Dipping clothing in gasoline will kill clothes moths, and articles so dipped and coming direct from the dry-cleaning process may be considered freed, temporarily at least, from moth infestation. Of course as soon as garments are dried after treatment they are subject to reinfestation. The use of gasoline for the treatment of wearing apparel most subject to moth attack is not advised for the average home because of the dangers and difficulties of application.

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